arXiv:astro-ph/0112129v1 6 Dec 2001

A New Era in Cosmology
ASP Conference Series, Vol. TBA, 2002
Editors: N. Metcalfe and T. Shanks

Searching for Clusters of Galaxies with SUMSS

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Abstract. Statistical overdensities of radio sources in the NRAO VLA Sky Survey (NVSS) catalogue have proven to be signposts to high-redshift clusters of galaxies. A similar search for overdensities has been carried out in the Sydney University Molonglo Sky Survey (SUMSS), which is closely matched in resolution and frequency to the NVSS. Sixty potential southern-hemisphere clusters have been found in SUMSS.

1. Introduction

Large numbers of distant ($z > 0.3$) clusters are now being identified by the new generation of X-ray telescopes, such as Chandra and XMM-Newton (Allen et al. 2001; Fabian et al. 2001). This will allow the study of the evolution of gas and galaxies within massive dark-matter halos. However, because of the n^2 dependence of thermal bremsstrahlung, X-ray selection of clusters is inevitably biased towards relaxed systems. Other cluster selection techniques, which can also reach high redshifts, are needed to complement the X-ray work.

A different approach to cluster selection is to look for overdensities of radio sources. Such overdensities are known to be signposts for high-redshift clusters of galaxies containing several radio-loud AGN. These clusters will form a very different sample to that of the high-redshift X-ray clusters; plausibly it will be biased towards merging systems if, for example, AGN activity is triggered by mergers.

This search technique has been carried out on the NRAO VLA Sky Survey (NVSS) with a high success rate. Optical observations indicate that approximately 65% of the overdensities of radio sources are indeed clusters of galaxies (Croft & Rawlings, private communication). Many $z > 0.3$ clusters have been found; TOC J0233.3+3021, which has optical and infrared magnitudes implying $z \sim 1$, was mapped by the Ryle Telescope at Cambridge and was found to have a detectable Sunyaev-Zel'dovich effect (Cotter et al. 2001).

2. Continuing the search in the Southern Hemisphere

The Sydney University Molonglo Sky Survey (SUMSS) is comparable to the NVSS survey. It has a resolution of 43 arcseconds at 843 MHz and identifies

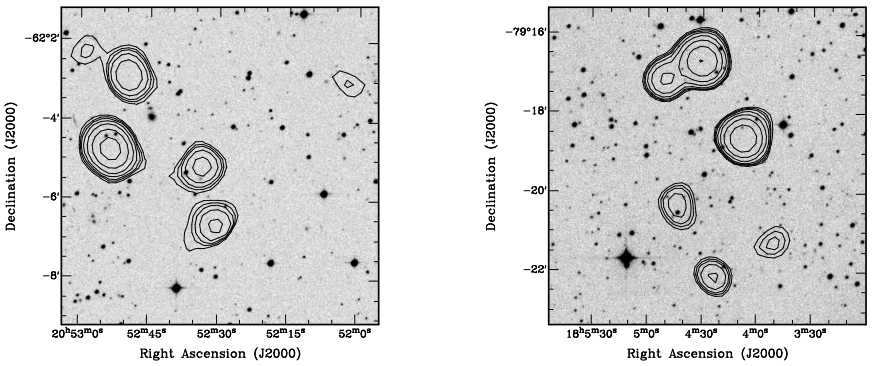

Figure 1. Two examples of clusters found in the SUMSS catalogue. The contours are from SUMSS and are at 4, 5, 6, 8, 12, 20, 36, 68 and 120 mJy/beam. The greyscale is an R-band image from SuperCOSMOS. Few of the sources have optical identifications, indicating that if these are clusters they will be at $z > 0.3$.

sources down to a level of 5 mJy. It follows that overdensities in this survey will also be signposts to clusters of galaxies.

We searched the SUMSS catalogue (Mauch, private communication) for overdensities of 5 or more radio sources inside a 7-arcminute radius. To weed out nearby clusters, we examine the SuperCOSMOS R-band data (Hambly et al. 2001). About 5% of the radio source overdensities prove to be Abell clusters, and another 35% have one or more optical identifications to the SuperCOSMOS limit of $R = 21.5$. The remaining overdensities are robust candidate $z > 0.3$ galaxy clusters. Sixty such candidates have been found to date; two are shown in Figure 1.

We will now embark on a detailed follow-up program that includes higher-resolution radio imaging at the ATCA, deeper imaging at the MSSSO 2.3-m and wide-field NIR imaging at the AAT. When we have assembled a sample of spectroscopically-confirmed clusters (using 8-m class telescopes for the most distant clusters), comparisons will be drawn between high-redshift X-ray- and radio source-selected samples. This will allow examination, for example, of the hypothesis that merging triggers multiple AGN activity in clusters.

Acknowledgments. HJB acknowledges a PPARC PhD studentship. GC acknowledges a PPARC Postdoctoral Research Fellowship.

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